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(71)出願人　000005821
松下電器産業株式会社
大阪府門真市大字門真1006番地
(72)発明者　江上　典彦
大阪府門真市大字門真1006番地　松下電器産業株式会社内
(74)代理人　100080827
弁理士　石原　勝

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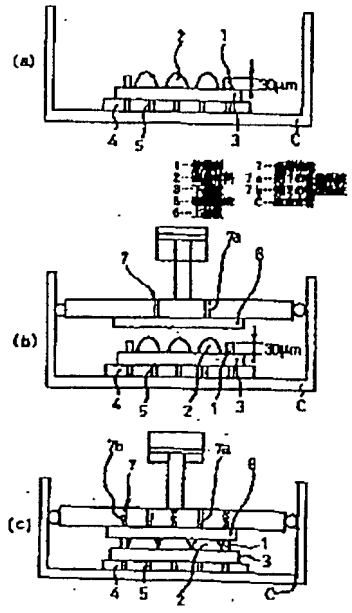
(54)【発明の名称】液晶表示素子製造装置および方法

(57)【要約】
【課題】　対向する位置に配置された２枚の基板を破損することなく精度良く貼り合わせることができる液晶表示素子製造装置を提供する。
【解決手段】　上面に接着剤１が塗布され液晶材料２が滴下された下基板３を大気雰囲気中にて真空容器Ｃ内に配置して下側の全面を真空吸着で固定し、下基板３に対向するように所定の間隔で上基板６を配置して上側の全面を真空吸着して固定し、真空雰囲気中にて両方又は一方の基板３、６を接近移動させて相互に加圧し、両基板３、６を貼り合わせるようにした液晶表示素子製造装置において、上基板６の上側全面を真空吸着する吸着機構７に複数の吸着系統７ａ、７ｂを設けて、大気中で上基板６を吸着固定する時の吸着力を抑制し、上基板６の破損を防止するようにした。



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【特許請求の範囲】

【請求項１】　上面に接着剤が塗布され液晶材料が滴下された下基板を大気雰囲気中にて真空容器内に配置して下側の全面を真空吸着で固定し、下基板に対向するように所定の間隔で上基板を配置して上側の全面を真空吸着して固定し、真空雰囲気中にて両方又は一方の基板を接近移動させて相互に加圧し、両基板を貼り合わせるようにした液晶表示素子製造装置において、上基板の上側全面を真空吸着する吸着機構に複数の吸着系統を設けたことを特徴とする液晶表示素子製造装置。

【請求項２】　両吸着系統は、大気圧中での吸着穴開口率よりも真空中での吸着穴開口率が大きくなるように構成したことを特徴とする請求項１記載の液晶表示素子製造装置。

【請求項３】　上面に接着剤が塗布され液晶材料が滴下された下基板を大気雰囲気中にて真空容器内に配置して下側の全面を真空吸着で固定し、下基板に対向するように所定の間隔で上基板を配置して上側の全面を真空吸着して固定し、真空雰囲気中にて両方又は一方の基板を接近移動させて相互に加圧し、両基板を貼り合わせるようにした液晶表示素子製造装置において、大気中で基板全面を平面で規制して吸着搬送する平面規制吸着搬送機構を設けたことを特徴とする液晶表示素子製造装置。

【請求項４】　上面に接着剤が塗布され液晶材料が滴下された下基板を大気雰囲気中にて真空容器内に配置して下側の全面を真空吸着で固定し、下基板に対向するように所定の間隔で上基板を配置して上側の全面を真空吸着して固定し、真空雰囲気中にて両方又は一方の基板を接近移動させて相互に加圧し、両基板を貼り合わせるようにした液晶表示素子製造装置において、上基板と下基板を加圧した後真空容器内で接着剤を硬化する手段を設けたことを特徴とする液晶表示素子製造装置。

【請求項５】　接着剤を硬化する手段が紫外線照射手段を備えることを特徴とする請求項４記載の液晶表示素子製造装置。

【請求項６】　接着剤を硬化する手段を大気中で接着剤を硬化するようにしたことを特徴とする請求項４記載の液晶表示素子製造装置。

【請求項７】　上面に接着剤が塗布され液晶材料が滴下された下基板を大気雰囲気中にて真空容器内に配置して下側の全面を真空吸着で固定し、下基板に対向するように所定の間隔で上基板を配置して上側の全面を真空吸着して固定し、真空雰囲気中にて両方又は一方の基板を接近移動させて相互に加圧し、両基板を貼り合わせるようにする液晶表示素子製造方法において、複数の吸着系統を設けた吸着機構によって上基板の上側全面を真空吸着することを特徴とする液晶表示素子製造方法。

【請求項８】　上面に接着剤が塗布され液晶材料が滴下された下基板を大気雰囲気中にて真空容器内に配置して下側の全面を真空吸着で固定し、下基板に対向するように所定の間隔で上基板を配置して上側の全面を真空吸着して固定し、真空雰囲気中にて両方又は一方の基板を接近移動させて相互に加圧し、両基板を貼り合わせるようにした液晶表示素子製造方法において、平面規制吸着搬送機構によって、大気中で基板全面を平面で規制して吸着搬送することを特徴とする液晶表示素子製造方法。

【請求項９】　上面に接着剤が塗布され液晶材料が滴下された下基板を大気雰囲気中にて真空容器内に配置して下側の全面を真空吸着で固定し、下基板に対向するように所定の間隔で上基板を配置して上側の全面を真空吸着して固定し、真空雰囲気中にて両方又は一方の基板を接近移動させて相互に加圧し、両基板を貼り合わせるようにした液晶表示素子製造方法において、上基板と下基板を加圧した後真空容器内で接着剤を硬化することを特徴とする液晶表示素子製造方法。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、パーソナルコンピュータやＴＶ受像機等の画像表示パネルとして用いられる液晶表示素子の製造装置および方法に関するものである。

【０００２】

【従来の技術】従来の液晶表示素子の製造装置について、図７～図１０を参照して説明する。

【０００３】液晶表示素子の構造は、図７に示すように、対向配置された透光性材料からなる下基板１１と上基板１２との間に一定ギャップを保つとともに、その間の空間に液晶材料１３を充填した状態で両者が紫外線硬化型の接着剤１４にて貼り合わされている。接着剤１４には下基板１１と上基板１２の間隔を一定に保つためのスペーサ１５（径５μｍ）が含まれている。

【０００４】このように液晶材料１３を接着剤１４の内側に配置する一方法として、図８に示すように、下基板１１に接着剤１４を厚み３０μｍで塗布した後（工程ａ）、接着剤１４の内側に液晶材料１３を滴下し（工程ｂ）、次に上基板１２を重ね合わせて上基板１２と下基板１１の間隔が５μｍになるまで加圧し（工程ｃ）、その後紫外線１６により接着剤１４を硬化させ（工程ｄ）、液晶表示素子を完成させる液晶滴下工法が知られている。

【０００５】以下、上記２枚の基板の貼り合わせ方法について、図９、図１０を参照して説明する。

【０００６】まず、表面に紫外線硬化型の接着剤１４が厚み３０μｍで塗布され、その接着剤１４の内側に液晶材料１３が配置された透光性材料からなる下基板１１を、水平方向に移動可能なテーブル１７上に搭載し、下基板１１の下側の全面を吸着機構１８による真空吸着で固定する（工程ａ）。

【０００７】次に、透光性材料からなる上基板１２の上側の全面を吸着機構１９による真空吸着で固定し、真空

容器Ｃを閉じて真空引きを行い、吸着機構１９を垂直方向に下降させて、上基板１２と液晶材料１３または接着剤１４を接触させる（工程ｂ）。次に、下基板１１を搭載したテーブル１７を水平方向に移動させて、下基板１１と上基板１２の位置合わせを行う（工程ｃ）。

【０００８】次に、吸着機構１９を垂直方向に下降させ、上基板１２を接着剤１４を介して下基板１１に貼り合わせ、５μｍまで加圧させる（工程ｄ）。その後、一体となった下基板１１と上基板１２を吸着機構２０により真空吸着して真空容器Ｃから取り出して搬送する（工程ｅ）。次に、紫外線１６を照射して接着剤を硬化させて下基板１１と上基板１２の貼り合わせが完了する（工程ｆ）。

【０００９】

【発明が解決しようとする課題】しかしながら、このような従来の装置では、真空容器の中で上基板の真空吸着を行うため、真空中での吸着力を確保するために広い吸着面積を要する。例えば、上基板の厚さが０．７ｍｍのガラスの場合は７０％の開口率を要する。そうすると、大気中で上基板１２の上側の全面を吸着機構１９で真空吸着して固定する時に吸着力が強すぎて、上基板１２が吸着機構１９に衝撃的に接触し、上基板１２を破損するという問題があった。

【００１０】また、下基板１１と上基板１２を貼り合わせ、５μｍまで加圧し、一体となった下基板１１と上基板１２を吸着機構２０による真空吸着で真空容器Ｃから取り出して搬送を行う時に、吸着パッド等による点吸着であるため、図１０の工程ｅに図示のごとく、下基板１１と上基板１２が撓んでしまい、下基板１１と上基板１２とが位置ずれを起こすという問題があった。

【００１１】また、一体となった下基板１１と上基板１２を吸着機構２０による真空吸着で真空容器Ｃから取り出して搬送を行い、別の装置により紫外線を照射して接着剤を硬化させるため、その間の移動により下基板１１と上基板１２が撓んでしまい、下基板１１と上基板１２とが位置ずれを起こすという問題があった。

【００１２】本発明は、上記従来の問題点に鑑み、対向する位置に配置された２枚の基板を破損することなく精度良く貼り合わせることができる液晶表示素子製造装置を提供することを目的としている。

【００１３】

【課題を解決するための手段】本発明の第１発明は、上面に接着剤が塗布され液晶材料が滴下された下基板を大気雰囲気中にて真空容器内に配置して下側の全面を真空吸着で固定し、下基板に対向するように所定の間隔で上基板を配置して上側の全面を真空吸着して固定し、真空雰囲気中にて両方又は一方の基板を接近移動させて相互に加圧し、両基板を貼り合わせるようにした液晶表示素子製造装置において、上基板の上側全面を真空吸着する吸着機構に複数の吸着系統を設けたものであり、大気中で上基板の上側の全面を吸着固定する時に吸着力を抑制できるので、上基板が吸着機構に衝撃的に接触して上基板が破損するのを防止できる。

【００１４】両吸着系統は、大気圧中での吸着穴開口率よりも真空中での吸着穴開口率が大きくなるように構成される。

【００１５】また、本発明の第２発明は、上面に接着剤が塗布され液晶材料が滴下された下基板を大気雰囲気中にて真空容器内に配置して下側の全面を真空吸着で固定し、下基板に対向するように所定の間隔で上基板を配置して上側の全面を真空吸着して固定し、真空雰囲気中にて両方又は一方の基板を接近移動させて相互に加圧し、両基板を貼り合わせるようにした液晶表示素子製造装置において、大気中で基板全面を平面で規制して吸着搬送する平面規制吸着搬送機構を設けたものであり、貼り合わせて一体となった下基板と上基板を撓みを生じさせることなく真空容器から搬送することができ、上基板と下基板の位置ずれを防止できる。

【００１６】また、本発明の第３発明は、上面に接着剤が塗布され液晶材料が滴下された下基板を大気雰囲気中にて真空容器内に配置して下側の全面を真空吸着で固定し、下基板に対向するように所定の間隔で上基板を配置して上側の全面を真空吸着して固定し、真空雰囲気中にて両方又は一方の基板を接近移動させて相互に加圧し、両基板を貼り合わせるようにした液晶表示素子製造装置において、上基板と下基板を加圧した後真空容器内で接着剤を硬化する手段を設けたものであり、上基板と下基板を加圧した後真空容器内で接着剤を硬化し、その後に真空容器から搬送することにより上基板と下基板の位置ずれを防止できる。

【００１７】接着剤を硬化する手段は、紫外線照射手段を備え、また大気中で接着剤を硬化するようにしたものが好適であるが、真空中で硬化させてもよい。

【００１８】

【発明の実施の形態】（第１の実施形態）本発明の第１の実施形態の液晶表示素子の製造装置について、図１、図２を参照して製造工程に沿って説明する。

【００１９】まず、表面に厚み３０μｍで塗布された紫外線硬化型の接着剤１及びその接着剤１の内側に液晶材料２が配置された透光性材料からなる下基板３を、水平方向に移動可能なテーブル４上に搭載し、下基板３の下側の全面を大気圧中にて吸着機構５による真空吸着で固定する（工程ａ）。

【００２０】次に、下基板３に対向するように所定間隔で、透光性材料からなる上基板６を配置し、この上基板６の上側面を大気中にて吸着機構７による真空吸着で固定する（工程ｂ）。この時、吸着機構７の第１の吸着系統７ａのみによって吸着固定する。次に、第２の吸着系統７ｂによる真空吸着を追加して吸着穴の開口率を大きくし、上基板６の全面を第１及び第２の吸着系統７ａ、

７ｂにて吸着固定する（工程ｃ）。

【００２１】次に、真空容器Ｃを閉じて真空引きを行い、真空雰囲気中にて両方又は一方の基板３、６を基板の対向方向に相対移動させて位置合わせを行う（工程ｄ）。次に、両方又は一方の基板３、６を接近移動させて相互に加圧し、両基板３、６を貼り合わせる（工程ｅ）。

【００２２】その後、貼り合わせた両基板３、６を真空容器Ｃの外部に搬送し、紫外線照射手段８にて紫外線を照射して接着剤１を硬化させて、下基板３と上基板６の貼り合わせが完了する（工程ｆ）。

【００２３】本実施形態によれば、大気中で上基板６の上側の全面を吸着機構７による真空吸着で固定する時に、第１の吸着系統７ａのみで吸着することで吸着力を抑制できるので、上基板６が吸着機構７ａ及び７ｂに衝撃的に接触することがなく、上基板６を破損することがなくなる。また、真空雰囲気中では第１と第２の吸着系統７ａ、７ｂで吸着固定するので、確実に固定される。

【００２４】（第２の実施形態）次に、本発明の第２の実施形態の液晶表示素子の製造装置について、図３、図４を参照して製造工程に沿って説明する。

【００２５】まず、表面に厚み３０μｍで塗布された紫外線硬化型の接着剤１及びその接着剤１の内側に液晶材料２が配置された透光性材料からなる下基板３を、水平方向に移動可能なテーブル４上に搭載し、下基板３の下側の全面を大気圧中にて吸着機構５による真空吸着で固定する（工程ａ）。

【００２６】次に、下基板３に対向するように所定間隔で、透光性材料からなる上基板６の上側の全面を吸着機構７による真空吸着で固定する（工程ｂ）。次に、真空容器Ｃを閉じて真空引きを行い、真空雰囲気中にて、両方又は一方の基板３、６を基板の対向方向に相対移動させて位置合わせを行う（工程ｃ）。次に、両方又は一方の基板３、６を接近移動させて相互に加圧し、両基板３、６を貼り合わせる（工程ｄ）。

【００２７】次に、貼り合わせた両基板３、６の基板全面を平面規制した状態で吸着する平面規制吸着搬送機構９にて真空吸着して真空容器Ｃの外部に搬送する（工程ｅ）。次に、紫外線照射手段８にて紫外線を照射して接着剤１を硬化させて、下基板３と上基板６の貼り合わせが完了する（工程ｆ）。

【００２８】本実施形態によれば、下基板３と上基板６を貼り合わせ、５μｍまで加圧後、一体となった下基板３と上基板６を平面規制吸着搬送機構９にて吸着して真空容器Ｃから取り出して搬送するので、搬送中に下基板３と上基板６が撓むことがなく、位置ずれを起こすことがない。

【００２９】（第３の実施形態）次に、本発明の第３の実施形態の液晶表示素子の製造装置について、図５、図６を参照して製造工程に沿って説明する。

【００３０】まず、表面に厚み３０μｍで塗布された紫外線硬化型の接着剤１及びその接着剤１の内側に液晶材料２が配置された透光性材料からなる下基板３を、水平方向に移動可能なテーブル４上に搭載し、下基板３の下側の全面を大気圧中にて吸着機構５による真空吸着で固定する（工程ａ）。

【００３１】次に、下基板３に対向するように所定間隔で、透光性材料からなる上基板６の上側の全面を吸着機構７による真空吸着で固定する（工程ｂ）。次に、真空容器Ｃを閉じて真空引きを行い、真空雰囲気中にて、両方又は一方の基板３、６を基板の対向方向に相対移動させて位置合わせを行う（工程ｃ）。次に、両方又は一方の基板３、６を接近移動させて相互に加圧し、両基板３、６を貼り合わせる（工程ｄ）。

【００３２】次に、真空容器Ｃ内のテーブル４上で、貼り合わされた両基板３、６が吸着固定された状態で紫外線照射手段８にて紫外線を照射して接着剤１を硬化させて、下基板３と上基板６の貼り合わせが完了する（工程ｅ）。その後、適宜搬送手段（図示せず）にて真空容器Ｃから取り出して搬送される。

【００３３】本実施形態によれば、下基板３と上基板６を貼り合わせ、５μｍまで加圧後、一体となった下基板３と上基板６に対して、同じ装置に設置した紫外線照射手段８にて紫外線を照射して接着剤１を硬化させるため、下基板３と上基板６が撓むことがなく、位置ずれを起こすことがない。なお、紫外線照射は、真空加圧中に行ってもよい。

【００３４】

【発明の効果】本発明の第１発明によれば、上基板の上側全面を真空吸着する吸着機構に複数の吸着系統を設けたので、大気中で上基板の上側の全面を吸着固定する時に吸着力を抑制できるので、上基板が吸着機構に衝撃的に接触して上基板が破損するのを防止できる。

【００３５】また、第２発明によれば、大気中で基板全面を平面で規制して吸着搬送する平面規制吸着搬送機構を設けたので、貼り合わせて一体となった下基板と上基板を撓みを生じさせることなく真空容器から搬送することができ、上基板と下基板の位置ずれを防止できる。

【００３６】また、第３発明によれば、上基板と下基板を加圧した後真空容器内で接着剤を硬化する手段を設けたので、上基板と下基板を加圧した後真空容器内で接着剤を硬化し、その後に真空容器から搬送することにより上基板と下基板の位置ずれを防止できる。

【図面の簡単な説明】

【図１】本発明の第１の実施形態の液晶素子製造装置による製造工程を示す模式断面図である。

【図２】同実施形態の製造工程の続きを示す模式断面図である。

【図３】本発明の第２の実施形態の液晶素子製造装置による製造工程を示す模式断面図である。

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【図４】同実施形態の製造工程の続きを示す模式断面図である。

【図５】本発明の第３の実施形態の液晶素子製造装置による製造工程を示す模式断面図である。

【図６】同実施形態の製造工程の続きを示す模式断面図である。

【図７】液晶表示装置の構造を示す模式断面図である。

【図８】液晶表示装置の製造工程を示す模式断面図である。

【図９】従来例の液晶表示装置の製造工程を示す模式断面図である。

【図１０】同従来例の液晶表示装置の製造工程の続きを示す模式断面図である。

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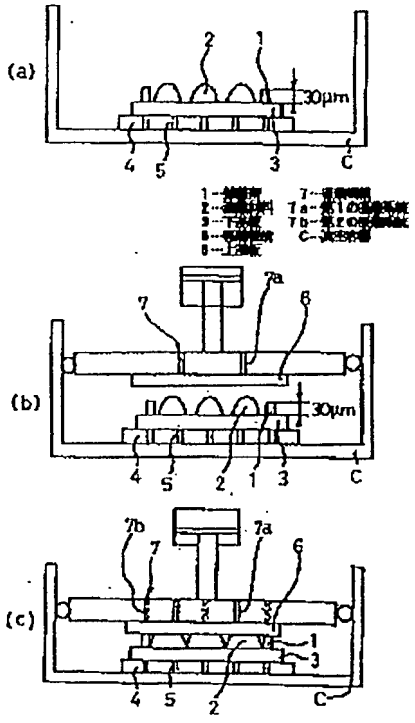
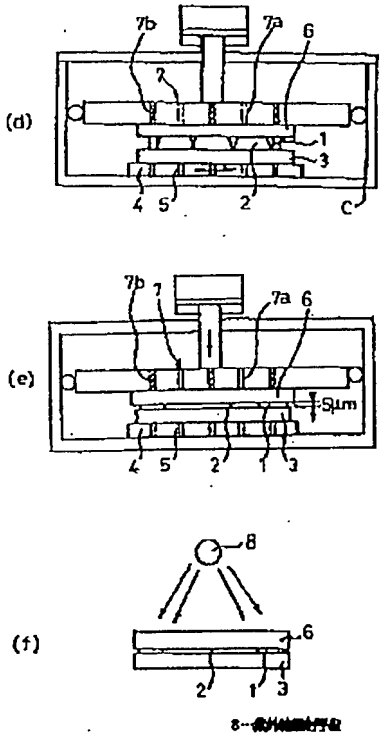
【符号の説明】

1　接着剤
2　液晶材料
3　下基板
5　吸着機構
6　上基板
7　吸着機構
7 a　第１の吸着系統
7 b　第２の吸着系統
8　紫外線照射手段
9　平面規制吸着搬送機構
C　真空容器

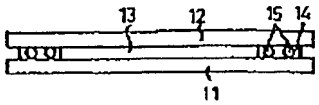
【図１】



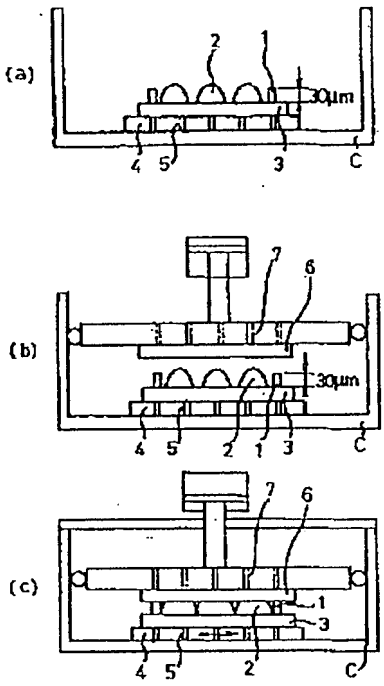
【図２】



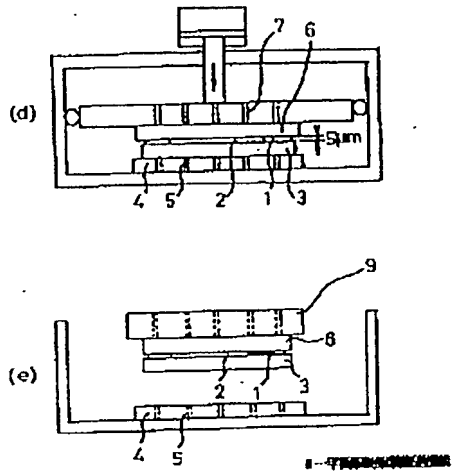
【図７】



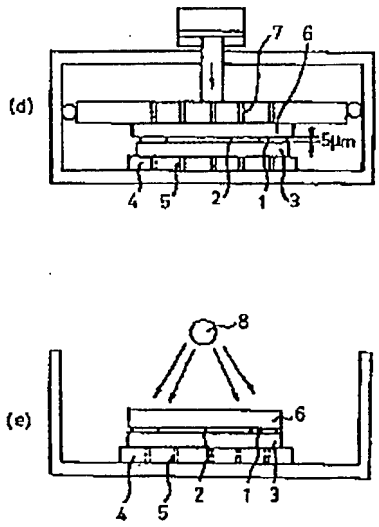
【図３】


(a)
2
1
30μm
4
5
3
C
(b)
7
6
30μm
4
5
2
1
3
C
(c)
7
6
1
3
4
5
2
C

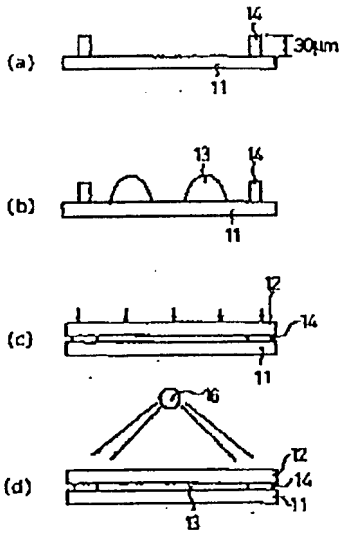
【図４】


(d)
7
6
5μm
4
5
2
1
3
(e)
9
8
2
1
3
4
5
(f)
8
6
2
1
3

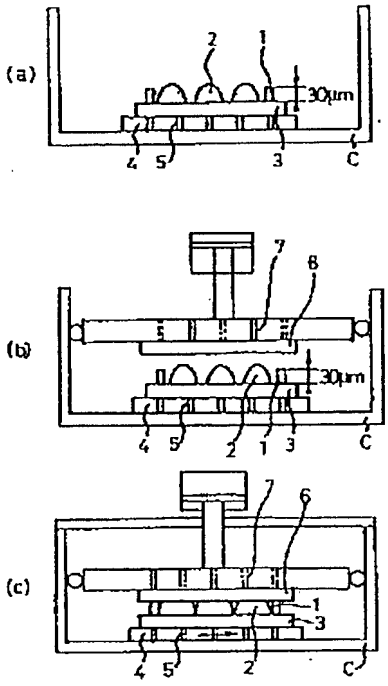
【図６】


(d)
7
6
5μm
4
5
2
1
3
(e)
8
6
4
5
2
1
3

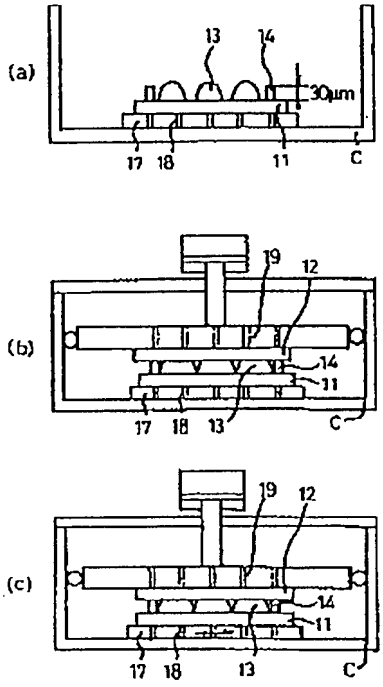
【図８】


(a)
14
30μm
11
(b)
13
14
11
(c)
12
14
11
(d)
16
12
14
11
13

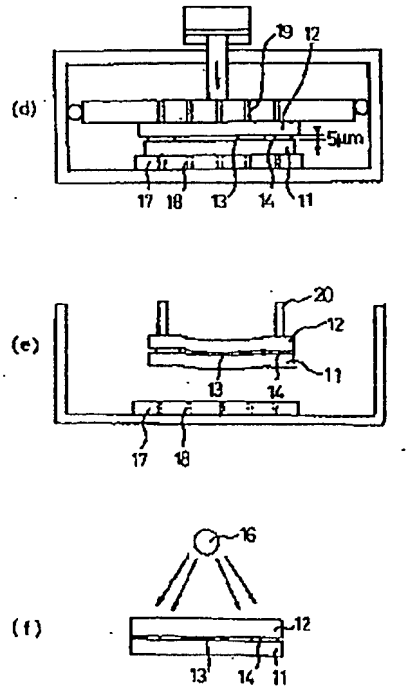
【図５】


(a)
2
1
30μm
4
5
3
C
(b)
7
6
30μm
4
5
2
1
3
C
(c)
7
6
1
3
4
5
2
C

【図９】


(a)
13
14
30μm
17
18
11
C
(b)
19
12
14
11
17
18
13
C
(c)
19
12
14
11
17
18
13
C

【図１０】



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MA20
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CA47 DA06 DB11 DC19 DC22
EA21 EA35
4F042 AA06 BA06 DB41 DF09
5F031 CA05 GA08

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[Title of the Invention] APPARATUS AND METHOD FOR MANUFACTURING LIQUID CRYSTAL DISPLAY DEVICE

[Abstract]

[Object] To realize an apparatus for manufacturing liquid crystal display devices capable of precisely joining two substrates which are opposed to each other without destruction of the substrates.

[Solving Means] An apparatus for manufacturing a liquid crystal display device in which a lower substrate 3 whose upper surface is coated with an adhesive 1 and to which a liquid crystal material 2 is dropped is arranged in a vacuum container C at atmospheric pressure, the whole lower surface is fixed by vacuum suction, an upper substrate 6 is arranged so as to be opposed to the lower substrate 3 at a prescribed interval, the whole upper surface is fixed by vacuum suction, both the substrates or either one of them are approached so as to bring into contact with each other, and both the substrates 3 and 6 are pressurized to join the substrates, wherein a plurality of suction systems 7a and b are equipped in a suction mechanism 7 which performs vacuum suction on the whole upper surface of the upper substrate 6 and a suction force is controlled when fixing the upper substrate 6 by the suction force at atmospheric pressure so that possible destruction of the upper substrate 6 can be

prevented.

[Claims]

[Claim 1] An apparatus for manufacturing a liquid crystal display device in which a lower substrate whose upper surface is coated with an adhesive and to which a liquid crystal material is dropped is arranged in a vacuum container at atmospheric pressure, the whole lower surface is fixed by vacuum suction, an upper substrate is arranged so as to be opposed to the lower substrate at a prescribed interval, the whole upper surface is fixed by vacuum suction, both the substrates or either one of them are approached so as to bring into contact with each other, and both the substrates are pressurized to join the substrates, wherein a plurality of suction systems are equipped in a suction mechanism by which the whole upper surface of the upper substrate is fixed by vacuum suction.

[Claim 2] The apparatus for manufacturing a liquid crystal display device according to Claim 1, wherein both suction systems have a structure that aperture ratio of a suction hole in vacuum is larger than at atmospheric pressure.

[Claim 3] The apparatus for manufacturing a liquid crystal display device in which a lower substrate whose upper surface is coated with an adhesive and to which a liquid crystal material is dropped is arranged in a vacuum

container at atmospheric pressure, the whole lower surface is fixed by vacuum suction, an upper substrate is arranged so as to be opposed to the lower substrate at a prescribed interval, the whole upper surface is fixed by vacuum suction, both the substrates or either one of them are approached so as to bring into contact with each other, and both the substrates are pressurized to join the substrates, wherein a plane-controlled suction transfer mechanism which controls the whole surface of the substrates to be a flat plane at atmospheric pressure is equipped.

[Claim 4] The apparatus for manufacturing a liquid crystal display device in which a lower substrate whose upper surface is coated with an adhesive and to which a liquid crystal material is dropped is arranged in a vacuum container at atmospheric pressure, the whole lower surface is fixed by vacuum suction, an upper substrate is arranged so as to be opposed to the lower substrate at a prescribed interval, the whole upper surface is fixed by vacuum suction, both the substrates or either one of them are approached so as to bring into contact with each other, and both the substrates are pressurized to join the substrates, wherein a method of curing the adhesive in the vacuum container after pressurizing the upper substrate and lower substrate is installed.

[Claim 5] The apparatus for manufacturing a liquid

crystal display device according to Claim 4, wherein ultraviolet ray irradiation method is provided for adhesive curing.

[Claim 6] The apparatus for manufacturing a liquid crystal display device according to Claim 4, wherein the adhesive curing at atmospheric pressure is provided as a adhesive curing method.

[Claim 7] The apparatus for manufacturing a liquid crystal display device in which a lower substrate whose upper surface is coated with an adhesive and to which a liquid crystal material is dropped is arranged in a vacuum container at atmospheric pressure, the whole lower surface is fixed by vacuum suction, an upper substrate is arranged so as to be opposed to the lower substrate at a prescribed interval, the whole upper surface is fixed by vacuum suction, both the substrates or either one of them are approached so as to bring into contact with each other, and both the substrates are pressurized to join the substrates, wherein the vacuum suction of the whole upper surface of the upper substrate is carried out by a suction mechanism equipped with a plurality of suction systems.

[Claim 8] An apparatus for manufacturing a liquid crystal display device in which a lower substrate whose upper surface is coated with an adhesive and to which a liquid crystal material is dropped is arranged in a vacuum

container at atmospheric pressure, the whole lower surface is fixed by vacuum suction, an upper substrate is arranged so as to be opposed to the lower substrate at a prescribed interval, the whole upper surface is fixed by vacuum suction, both the substrates or either one of them are approached so as to bring into contact with each other, and both the substrates are pressurized to join the substrates, wherein a plane-controlled suction transfer mechanism controls the whole surface of the substrates to be a flat plane and performs a suction transfer at atmospheric pressure.

[Claim 9] An apparatus for manufacturing a liquid crystal display device in which a lower substrate whose upper surface is coated with an adhesive and to which a liquid crystal material is dropped is arranged in a vacuum container at atmospheric pressure, the whole lower surface is fixed by vacuum suction, an upper substrate is arranged so as to be opposed to the lower substrate at a prescribed interval, the whole upper surface is fixed by vacuum suction, both the substrates or either one of them are approached so as to bring into contact with each other, and both the substrates are pressurized to join the substrates, wherein the adhesive is cured in the vacuum container after pressurizing the upper substrate and lower substrate.

[Detailed Description of the Invention]

[0001]

[Technical Field of the Invention]

The present invention relates to an apparatus and method for manufacturing a liquid crystal display device which is used as an image display panel for personal computers or television sets.

[0002]

[Description of the Related Art]

A conventional method for manufacturing a liquid crystal display device will be described with reference to Figs. 7 to 10.

[0003]

In the structure of the liquid crystal display device, as shown in Fig. 7, a regular gap is held between a lower substrate 11 and an upper substrate 12 which are opposed to each other and consist of light-penetrating material, an electrically charged liquid crystal material 13 is filled in the gap, and both the substrates 11 and 12 are joined with each other by an ultraviolet ray curing type adhesive 14. The adhesive 14 contains a spacer 12 for holding a regular interval (a diameter of 5 μm) between the upper substrate 12 and the lower substrate 11.

[0004]

As a method for arranging a liquid crystal material 13 in the adhesive 14, as shown in Fig. 8, there is a liquid crystal dropping method including coating the adhesive 14 on

the lower substrate 11 with a thickness of 30 μm (process a), dropping the liquid crystal material 13 in the adhesive 14 (process b), superposing the upper substrate 12 on the lower substrate 11 and pressurizing both the substrates 11 and 12 until the interval between the upper substrate 12 and the lower substrate 11 becomes 5 μm (process c), and then curing the adhesive 14 by ultraviolet rays 16(process d) to complete a liquid crystal display device.

[0005]

Hereinafter, a method for joining the two substrates will be described in detail with reference to Figs. 9 and 10.

[0006]

First, the lower substrate 11 whose upper surface is coated with an ultraviolet ray curing type adhesive 14 with a thickness of 30 μm and to which a liquid crystal material 13 is arranged in the adhesive 14 is mounted on a horizontally movable table 17, and the whole lower surface of the lower substrate 11 is fixed by a vacuum suction force of a suction mechanism 18 (process a).

[0007]

Next, the upper substrate 12 which consists of light-penetrating material is fixed by a vacuum suction force of a suction mechanism 19, a vacuum container C is closed, and the suction mechanism 19 is vertically lowered so that the upper substrate 12 is brought into contact with the liquid

crystal material 13 or the adhesive 14 (process b). Next, the table 17 having the lower substrate 11 mounted thereon is moved in a horizontal direction, so that the upper substrate 12 and the lower substrate 11 are aligned (process c).

[0008]

Next, the suction mechanism 19 is vertically lowered so that the upper substrate 12 is brought into contact with the lower substrate 11 by means of the adhesive 14, and pressurized until the interval between the two substrates becomes 5 μm (process d). Thereafter, the joined lower and upper substrates 11 and 12 are fixed by a vacuum suction force of a suction mechanism 20 and transferred out from the vacuum container C (process e). Next, ultraviolet rays 16 are irradiated to cure the adhesive 14, and thus the joining of the lower substrate 11 and upper substrate 12 is completed.

[0009]

[Problems to be Solved by the Invention]

However, in the conventional method, since the vacuum suction is performed on the upper substrate 12 in the vacuum container, a wide suction area is required to ensure the vacuum suction force. For example, a glass having the upper substrate with a thickness of 0.7 mm requires 70% of aperture ratio. Accordingly, the suction force becomes

excessive when fixing the whole upper surface of the upper substrate 12 by the vacuum suction force of the suction mechanism 19 at atmospheric pressure. As a result, the upper substrate 12 is brought into abrupt contact with the suction mechanism 19, which leads to a problem of possible destruction of the upper substrate 12.

[0010]

Also, point suction by using a suction pad is applied when the lower substrate 11 and upper substrate 12 are joined and pressurized so that the interval between the substrates becomes 5 μm, and thus the joined lower substrate 11 and upper substrate 12 are transferred out from the vacuum container C by the vacuum suction force of the suction mechanism 20. Thus, as shown in the process e of Fig. 10, the lower substrate 11 and upper substrate 12 are distorted, which leads to a position deviation of the lower substrate 11 and the upper substrate 12.

[0011]

Also, since the joined lower substrate 11 and upper substrate 12 are transferred out from the vacuum container C by the vacuum suction force of the suction mechanism 20 and irradiated by the ultraviolet rays to cure the adhesive by means of a separate unit, the lower substrate 11 and upper substrate 12 are distorted during moving the substrates. Thus, the positional deviation occurs in the lower substrate

11 and the upper substrate 12.

[0012]

An object of the present invention is to provide an apparatus for manufacturing a liquid crystal display device capable of precisely joining two substrates which are arranged so as to be opposed to each other without destruction of the substrates.

[0013]

[Means for Solving the Problems]

According to the present invention, there is provided an apparatus for manufacturing a liquid crystal display device in which a lower substrate whose upper surface is coated with an adhesive and to which a liquid crystal material is dropped is arranged in a vacuum container at atmospheric pressure, the whole lower surface is fixed by vacuum suction, an upper substrate is arranged so as to be opposed to the lower substrate at a prescribed interval, the whole upper surface is fixed by vacuum suction, both the substrates or either one of them are approached so as to bring into contact with each other, and both the substrates are pressurized to join the substrates, wherein a plurality of suction systems are equipped in a suction mechanism which performs vacuum suction on the whole upper surface of the upper substrate so that suction force can be controlled when fixing the upper substrate at atmospheric pressure. Thus,

possible destruction of the upper substrate can be prevented when the upper substrate is brought into contact with a suction mechanism.

[0014]

Both suction systems are constructed so as to have a suction hole whose aperture ratio in vacuum is larger than at atmospheric pressure.

[0015]

According to the present invention, there is also provided a method for manufacturing a liquid crystal display device in which a lower substrate whose upper surface is coated with an adhesive and to which a liquid crystal material is dropped is arranged in a vacuum container at atmospheric pressure, the whole lower surface is fixed by vacuum suction, an upper substrate is arranged so as to be opposed to the lower substrate at a prescribed interval, the whole upper surface is fixed by vacuum suction, both the substrates or either one of them are approached so as to bring into contact with each other, and both the substrates are pressurized to join the substrates, wherein a plane-controlled suction transfer mechanism controls the whole surface of the substrates to be a flat plane at atmospheric pressure so that the joined lower substrate and upper substrate can be transferred out from the vacuum container without generating distortion of the substrates. Thus, the

positional deviation of the upper substrate and the lower substrate can be avoided.

[0016]

According to the present invention, there is also provided a method for manufacturing a liquid crystal display device in which a lower substrate whose upper surface is coated with an adhesive and to which a liquid crystal material is dropped is arranged in a vacuum container at atmospheric pressure, the whole lower surface is fixed by vacuum suction, an upper substrate is arranged so as to be opposed to the lower substrate at a prescribed interval, the whole upper surface is fixed by vacuum suction, both the substrates or either one of them are approached so as to bring into contact with each other, and both the substrates are pressurized to join the substrates, wherein the adhesive is cured in the vacuum container after pressurizing the upper substrate and the lower substrate. Since the adhesive is cured in the vacuum container after pressurizing the upper substrate and the lower substrate, and then transferred from the vacuum container, the positional deviation of the upper substrate and the lower substrate can be avoided.

[0017]

The adhesive is preferably cured by means of irradiating the ultraviolet rays and curing the adhesive at

atmospheric pressure, but a vacuum curing is also appropriate.

[0018]

[Description of the Embodiments]

Hereinafter, an apparatus for manufacturing a liquid crystal display device according to a first embodiment of the present invention will be described with reference to Figs. 1 and 2.

[0019]

First, a lower substrate 3 whose upper surface is coated with an ultraviolet ray curing type adhesive 1 with a thickness of 30 μm and to which a liquid crystal material 2 is arranged in the adhesive 1 is mounted on a horizontally movable table 4, and the whole lower surface of the lower substrate 3 is fixed by a vacuum suction force of a suction mechanism 5 (process a).

[0020]

Next, the upper surface of an upper substrate 6 consisting of light-penetration material is arranged so as to be opposed to the lower substrate 3, and fixed by a vacuum suction force of a suction mechanism 7(process b). Here, the suction fixation is carried out by only the first suction system 7a of the suction mechanism 7. Then, additional suction fixation is carried out by the second suction system 7b, the aperture ratio of a suction hole is

enlarged, and the whole surface of the upper substrate 6 is fixed by the first and the second suction systems 7a and b (process c).

[0021]

Next, a vacuum container C is closed and evacuated and then both or either of the substrates 3 and 6 are aligned in vacuum so as to be opposed to each other (operation 6). Then, both or either of the substrates 3 and 6 are approached to each other so as to be pressurized and then joined (process e).

[0022]

Next, the joined both substrates 3 and 6 is transferred out from the vacuum container C, ultraviolet rays are irradiated by an ultraviolet irradiation method 8 to cure an adhesive 1, and the joining of the lower substrate 3 and the upper substrate 6 is completed (process f).

[0023]

According to the first embodiment of the present invention, when fixing the whole upper surface of the upper substrate 6 by the vacuum suction force of the suction mechanism 7 at atmospheric pressure, the suction force can be controlled by using only the first suction system 7a. As a result, the upper substrate 6 is no longer brought into abrupt contact with the suction mechanism 7a and b, and thus the possible destruction of the upper substrate 6 is removed.

Also, suction fixation in vacuum is surely ensured, since it is carried out by the first and the second suction systems 7a and b.

[0024]

Next, an apparatus for manufacturing a liquid crystal display device according to a second embodiment of the present invention will be described with reference to Figs. 3 and 4.

[0025]

First, a lower substrate 3 whose upper surface is coated with an ultraviolet ray curing type adhesive 1 with a thickness of 30 μm and to which a liquid crystal material 2 is arranged in the adhesive 1 is mounted on a horizontally movable table 4, and the whole lower surface of the lower substrate 3 is fixed by a vacuum suction force of a suction mechanism 5 (process a).

[0026]

Next, the upper surface of an upper substrate 6 consisting of light-penetration material is fixed by a vacuum suction force of a suction mechanism 7 (process b). Next, a vacuum container C is closed and evacuated and then both or either of the substrates 3 and 6 are aligned in vacuum so as to be opposed to each other (process c). Then, both or either of the substrates 3 and 6 are approached to each other so as to be pressurized and then joined (process

d).

[0027]

Next, a vacuum suction is performed on the joined both substrates 3 and 6 by a suction transfer mechanism 9 which controls the whole surface of the substrates to be a flat panel. Then the substrates are transferred out from the vacuum container C. Next, ultraviolet rays are irradiated by an ultraviolet irradiation method 8 to cure an adhesive 1, and the joining of the lower substrate 3 and the upper substrate 6 is completed (process f).

[0028]

According to the second embodiment of the present invention, the lower substrate 3 and the upper substrate 6 are joined and pressurized so that the interval between the lower and upper substrates becomes 5 μm. Since the vacuum suction is performed on the joined substrates 3 and 6 by the suction transfer mechanism 9 which controls the whole surface of the substrates to be a flat panel, the possible distortion of the lower substrate 3 and upper substrate 6 during transferring is removed. Thus, the positional deviation of the upper substrate and the lower substrate can be avoided.

[0029]

Next, an apparatus for manufacturing a liquid crystal display device according to a third embodiment of the

present invention will be described with reference to Figs. 5 and 6.

[0030]

First, a lower substrate 3 whose upper surface is coated with an ultraviolet ray curing type adhesive 1 with a thickness of 30 μm and to which a liquid crystal material 2 is arranged in the adhesive 1 is mounted on a horizontally movable table 4, and the whole lower surface of the lower substrate 3 is fixed by a vacuum suction force of a suction mechanism 5 (process a).

[0031]

Next, the upper surface of an upper substrate 6 consisting of light-penetration material is fixed by a vacuum suction force of a suction mechanism 7 (process b). Next, a vacuum container C is closed and evacuated and then both or either of the substrates 3 and 6 are aligned in vacuum so as to be opposed to each other (process c). Then, both or either of the substrates 3 and 6 are approached to each other so as to be pressurized and then joined (process d).

[0032]

Next, on the table 4 in the vacuum container C, the joined substrates 3 and 6 remain fixed by the suction fixation, ultraviolet rays are irradiated by an ultraviolet irradiation method 8 to cure an adhesive 1, and the joining

of the lower substrate 3 and the upper substrate 6 is completed (process e). Thereafter, the substrates are removed from the vacuum container C and transferred by a transfer means (not shown).

[0033]

According to the third embodiment of the present invention, the lower substrate 3 and the upper substrate 6 are joined and pressurized so that the interval between the lower and upper substrates becomes 5 μm. Next, on the joined lower substrate 3 and upper substrate 6, the ultraviolet rays are irradiated by the ultraviolet irradiation method installed in the same apparatus to cure the adhesive 1. Thus, the possible distortion of the lower substrate 3 and upper substrate 6 is removed and the positional deviation of the upper substrate and the lower substrate can be avoided. Also, the ultraviolet radiation may be performed in vacuum.

[0034]

[Advantages]

According to the first embodiment of the present invention, since a plurality of suction systems are equipped in the suction mechanism which performs vacuum suction on the whole surface of the upper substrate, the vacuum suction force can be controlled during the suction fixation of the whole upper surface of the upper substrate at atmospheric

pressure. Thus, it can be avoided that the upper substrate is brought into abrupt contact with the suction mechanism, which leads to the possible destruction of the upper substrate.

[0035]

Also, according to the second embodiment of the present invention, suction transfer is carried out by a panel-controlled suction transfer mechanism which controls the whole surface of the substrates to be a flat panel at atmospheric pressure. As a result, the lower substrate and upper substrate can be transferred out from the vacuum container without generating distortion. Thus, the positional deviation of the upper substrate and the lower substrate can be avoided.

[0036]

Also, according to the third embodiment of the present invention, a method of curing the adhesive in the vacuum container after pressuring the upper substrate and the lower substrate is installed. Since the adhesive is cured in the vacuum container after pressurizing the upper substrate and the lower substrate and then transferred out from the vacuum container, the positional deviation of the upper substrate and the lower substrate can be avoided.

[Brief Description of the Drawings]

[Fig. 1]

Fig. 1 is a schematic cross-sectional view of processes of an apparatus for manufacturing a liquid crystal display device according to a first embodiment of the present invention.

[Fig. 2]

Fig. 2 is a schematic cross-sectional view of the following processes of Fig. 1.

[Fig. 3]

Fig. 3 is a schematic cross-sectional view of processes of an apparatus for manufacturing a liquid crystal display device according to a second embodiment of the present invention.

[Fig. 4]

Fig. 4 is a schematic cross-sectional view of the following processes of Fig. 3.

[Fig. 5]

Fig. 3 is a schematic cross-sectional view of processes of an apparatus for manufacturing a liquid crystal display device according to a third embodiment of the present invention.

[Fig. 6]

Fig. 6 is a schematic cross-sectional view of the following processes of Fig. 5.

[Fig. 7]

Fig. 7 is a schematic cross-sectional view of structure

of a liquid crystal display device.

[Fig. 8]

Fig. 8 is a schematic cross-sectional view of manufacturing process of a liquid crystal display device

[Fig. 9]

Fig. 9 is a schematic cross-sectional view of processes of a conventional apparatus for manufacturing a liquid crystal display device.

[Fig. 10]

Fig. 10 is a schematic cross-sectional view of the following processes of Fig. 9.

[Reference Numerals]

1: adhesive

2: liquid crystal material

3: lower substrate

5: suction mechanism

6: upper substrate

7: suction mechanism

7a: first suction system

7b: second suction system

8: ultraviolet ray irradiation method

9: plane-controlled suction transfer mechanism

C: vacuum container